PC24E and PC25E

HIGH SPEED

FOUR CHANNEL

DIGITAL TO ANALOG

CONVERTER

BOARDS

This Instruction Manual is supplied with the PC24E or PC25E to provide the user with sufficient information to utilise the product in a proper and efficient manner. The information contained has been reviewed and is believed to be accurate and reliable, however **Amplicon Liveline Limited** accepts no responsibility for any problems caused by errors or omissions. Specifications and instructions are subject to change without notice.

PC24E and PC25E Instruction Manual Part Nº 859 561 84 Issue A3

Prepared by Technical Publications
Approved for issue by A.S. Gorbold, Operations Director

DECLARATION OF CONFORMITY

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We declare that the product(s) described in this Instruction Manual are manufactured by Amplicon Liveline Limited and perform in conformity with the following standards or standardisation documents:

Electro Magnetic Compatibility (EMC):

EMC Directive	89/336/EEC
LVD Directive	73/23/EEC
CE Directive	93/68/EEC

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PC24E AND PC25E

HIGH SPEED FOUR CHANNEL D to A CONVERTER BOARD

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PC24E AND PC25E

HIGH SPEED FOUR CHANNEL D to A CONVERTERS

1. GENERAL INFORMATION

1.1 General Description

The PC24E and PC25E are four channel, 12-bit digital to analog converter cards for installation in an IBM PC/XT/AT, PS2/30 or compatible computer.

The **PC24E** is a four channel analog voltage output card with individual jumper selectable output ranges of 0 to +2.5v, ± 2.5v or 0 to +10v, ±10v.

The **PC25E** is a four channel analog current output card, sourcing 4 **-** 20 mA between current output and ground. The output stages of the PC25E can be powered from the internal +12v supply rail or from a 24 volt external supply when the driven impedance is high.

The flexible addressing system provided on the board allows the base address to be set within the range 000 to FF0 hex. A set of jumpers allows selection of an interrupt level within the range IRQ2 to IRQ7.

A 1MHz on-board oscillator provides an accurate source for the counter/timers, independent of the system clock frequency. The oscillator can be disabled if the small amount of noise injected into the analog outputs is not acceptable.

Windows DLLs with Visual Basic examples, and demonstration software written in Turbo Pascal is included.

1.2 What the Package Contains

The package as delivered from Amplicon Liveline Ltd. contains:-

1. The PC24E or PC25E plug-in card protected by an anti-static plastic envelope.

⚠ CAUTION SOME OF THE COMPONENTS ON THE BOARD ARE SUSCEPTIBLE TO DAMAGE BY ELECTROSTATIC DISCHARGE, AND PROPER HANDLING PRECAUTIONS SHOULD BE OBSERVED. AS A MINIMUM, AN EARTHED WRIST STRAP MUST BE WORN WHEN HANDLING THE PC24E/25E. FULL STATIC HANDLING PROCEDURES ARE DEFINED IN BRITISH STANDARDS PUBLICATION BS5753.

WHEN REMOVED FROM THE BAG, INSPECT THE BOARD FOR ANY OBVIOUS SIGNS OF DAMAGE AND NOTIFY AMPLICON IF SUCH DAMAGE IS APPARENT. DO NOT PLUG A DAMAGED BOARD INTO THE HOST COMPUTER. KEEP THE PROTECTIVE BAG FOR POSSIBLE FUTURE USE IN TRANSPORTING THE BOARD.

2. The Windows DLLs and demonstration software on 3.5 inch diskettes (part nº 85956184).

3. This PC24E/25E Instruction Manual (Amplicon part number 859 561 84).

Any additional accessories (terminal assembly and cable etc.) may be packed separately.

1.3 Features

- Four 12-bit digital to analog converters.
- Unipolar or Bipolar operation in four user selectable ranges (PC24E only).
- 4-20mA output (PC25E only).
- On-board 1MHz frequency reference that can be disabled for ultra quiet operation.
- Two triggering modes.
- Flexible addressing.
- On-board programmable wait state generator for compatibility with faster machines.

2. USING THE PC24E/25E

2.1 General Information

The PC24E/25E is supplied with the Amplicon Introductory DLL package - a suite of Windows DLLs with Microsoft Visual Basic example programs which support Amplicon's range of low-cost data acquisition boards, namely PC14AT, PC24E, PC25E, PC27E, PC26AT, PC30AT, and PC36AT.

The PC24E/PC25E is also supplied complete with demonstration software written in Borland Turbo Pascal. The source code for the demonstration program is supplied and is compatible with compiler versions 4 and above.

A number of user settings are available on the board, and these should be configured to the user's requirements before installing the PC24E/25E in the host computer.

2.2 Requirements to Run the Software

The following software and hardware are required in order to enable the program to be run:

- Windows 3.1 or later.
- An IBM PC or compatible.
- PC24E or PC25E (fitted).
- 3 1/2 inch disk drive.
- A monitor.

2.3 Backing up the Software Diskette

It is important that you make a backup copy of the software diskette and store the original in a cool dry safe place. The diskette can be copied onto another, blank diskette by using the MS-DOS command:

```
DISKCOPY A: A:
```

on a single drive machine, or:

```
DISKCOPY A: B:
```

on a twin drive machine.

Always use the copy for your work. Running the software is described in section 4.

2.4 Installing the Software onto a Fixed Hard Disk

To install the software onto your hard disk, insert the diskette into drive A and select File|Run... from the Windows Program Manager, or if you are using Windows 95 select Run... from the Start menu. In the dialogue box that follows, type

A:\SETUP <RETURN>

The PC24E/25E software setup program will now run. Follow the instructions given on the screen to complete the installation. See Section 4 'Programming the PC24E/25E' for details on running the software.

2.5 User Settings

The PC24E or PC25E can be operated at the factory default settings of the switches and jumpers, but to configure the board to specific requirements without conflict with other possible functions of the host computer, all operations described in this section should be checked.

2.5.1 Board Base Address

The PC24E/PC25E can have its base address situated within the range 000 to FF0 hex. This feature provides the flexibility to avoid any contention in I/O mapping that may arise and allows the use of multiple cards fitted in the PC expansion slots.

2.5.1.1 Factory Setting

The board's base address is set at the factory to be 300 hex.

2.5.1.2 Customer Configured Base Address

The board's base address can be selected as any sixteenth address within the range 000 to FF0 hex by means of the appropriate settings of switch SW1. This switch bank comprises a row of eight single pole switches with each 'ON' (up) position selecting a logic 0, and each 'OFF' (down) position selecting a logic 1. The most significant hex digit is coded by the four most left switches and the middle hex digit is coded by the four most right switches of SW1. The least significant digit is fixed at zero.

Figure 1 below shows the factory setting of the base address at 300 hex

Most significant digit	0011	= 3 hex
Middle digit	0000	= 0 hex
Least significant	Fixed	= 0 hex

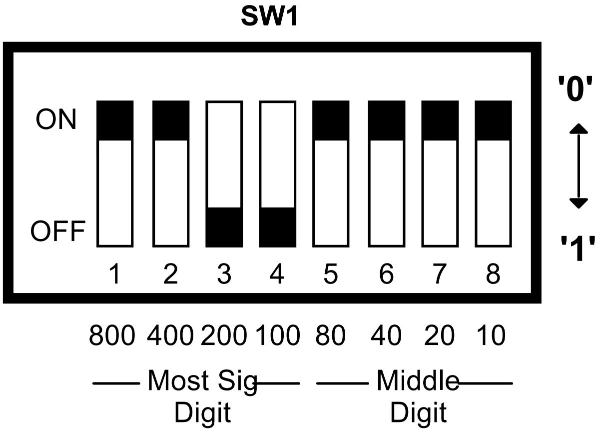


Figure 1 SW1 DIL SWITCH SELECTION OF BASE ADDRESS

2.5.2 Interrupt Request Selection

To accurately time DAC output waveforms, a programmable clock interrupts the host computer on a selected IRQ level at the required intervals.

2.5.2.1 Jumper Setting of IRQ Level

An interrupt level must be chosen that is not otherwise used in the system. Note that unless the interrupts are specifically supported by the software in use, the interrupt has no effect on the PC bus.

The IRQ level to be used is selected on J13. Only one level may be selected by positioning a single jumper at the required IRQ level 2 to 7 as illustrated in figure 2.

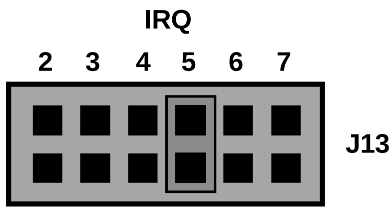


Figure 2 IRQ LEVEL SELECTION

2.5.2.2 Jumper Setting of Programmable Timer

1. Generating an Interrupt

The interrupts are generated by the counter/timer QA14 which is an 82C53 and fully described in the data sheets contained in the appendix.

A crystal oscillator provides an accurate 1MHz source which is hard wired to clock 0 input. Jumper J10 selects the output from any one of the three possible timer outputs. These are labeled '0' for counter 0, '1' for counter 1 and '2' for counter 2. To use counter 1, its input may be cascaded to the output of counter 0. This is done by plugging jumper J12 in the 'UP' position. With J12 in the 'DOWN' position, counter 0 output is directed to the output connector, PL1 pin 16. Similarly with J11 in the 'UP' position, counter 2 input is cascaded to

the output of counter 1, and in the 'DOWN' position, counter 1 output is available at the output connector, PL1 pin 4. For counter 2 to generate a hardware interrupt, it must be cascaded with counter 1 and counter 0.

The various configurations of jumpers J10, 11 and 12 for internal interrupt generation are shown in figure 3.

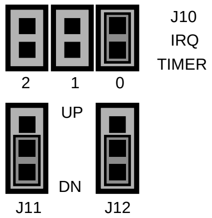
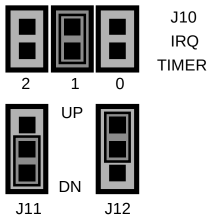
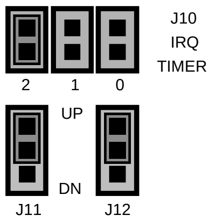
Timer Range	Counters In Use	Jumper Configuration	External Outputs
2 µSecs to 65 mSecs	Cntr 0 IRQ from Cntr 0		Cntr 0
4 µSecs to 70 Mins	Ctrs 0 and 1 IRQ from Cntr 1		Cntr 1
8 µSecs to >24 Hrs	Ctrs 0, 1 and 2 IRQ from Cntr 2		None

Figure 3 CLOCK JUMPER SELECTION

2. General Purpose Use

If no IRQ generation is required, the counter/timers can be used for any counting/timing function, and the Clock, Gate and Output signals of each counter/timer are available on the output connector PL1, with the exception of Counter 0 Clock, which is hard wired to the crystal oscillator's 1MHz source, and Counter 0 Gate, which is set at +5V (permanently enabled). Figure 4 shows the general jumper configuration for the counter/timers.

If no IRQ generation is required, and the counter/timers are not in use, it is recommended that the on-board oscillator is disabled by inserting J14.

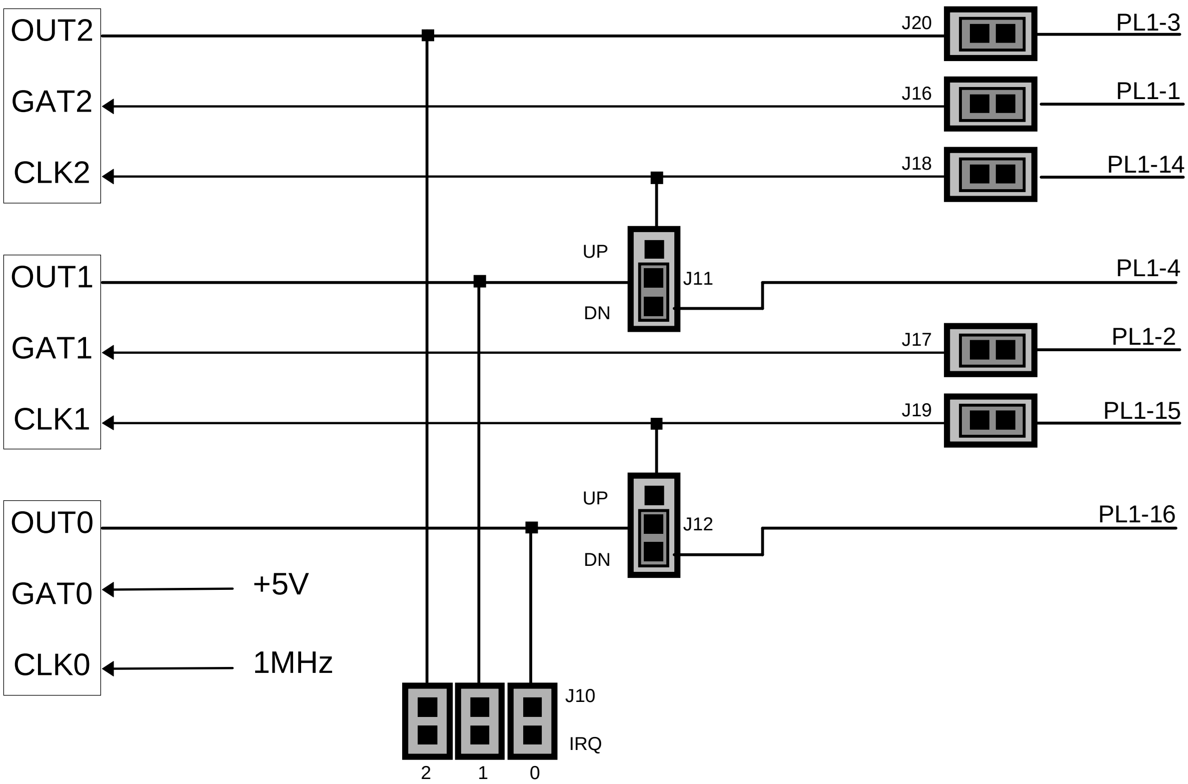


Figure 4 GENERAL PURPOSE CLOCK JUMPER SELECTION

2.5.3 Wait State Generator Setting (Option)

The PC24E/PC25E has an option to incorporate an on-board wait state generator (QA19) to enable it to operate reliably in a wide range of PC/XT/AT and ISA machines. The need for this is because some machines, that are otherwise IBM compatible, operate the I/O expansion bus at clock frequencies higher than the 8 MHz specified in the ISA standard. This option is not fitted as standard.

Many interface ICs currently available cannot operate at these higher frequencies and it becomes necessary to slow down the bus interface signals, locally, on the PC24E/PC25E board. The degree of retardation can be adjusted to give optimum performance in any machine. Being local to the PC24E/PC25E board, this slowing down in no way impairs the performance of the host computer.

The expansion bus frequency is not necessarily the same as that of the main processor clock. A computer which is specified as a 12 or 16 MHz machine could well have an expansion bus frequency of 8 MHz. Unless explicitly stated in the machine specification there is no easy way to establish the speed of the expansion bus.

If you can establish the expansion **bus** clock frequency for your machine, use figure 5 to set the appropriate number of wait states. If the expansion bus clock frequency is unknown, it is suggested that you leave the number of wait states at the default setting of zero (No jumper). If the operation is erratic, increase the wait states to 1, 2 or 3 by plugging in a single jumper, until proper operation is achieved. If the number of wait states is set too high, the response of the PC24E/25E will not be optimum. Some computers will not tolerate wait states on expansion boards, in which case the jumper J15 must always be left out.

Nº OF WAIT STATES	EXPANSION BUS SPEED	J15 JUMPER SETTING
0	Up to 8 MHz	No jumper
1	8 to 10 MHz	3
2	10 to 12 MHz	4
3	12 MHz and above	5

Figure 5 J15 Wait State Settings

2.5.4 DAC Loading Mode

Each Digital to Analog Converter (DAC) has twelve bits resolution and the data word is right justified and loaded sequentially in two bytes, the least significant byte (LSB) of eight bits and the most significant byte (MSB) of four active bits. Jumper facilities are provided so that the data word can be loaded either MSB last or LSB last. The correct setting of the jumpers relative to the user's program will ensure that the DAC analog output is updated when both bytes have been loaded.

Jumpers J6, J7, J8 and J9 select the loading mode for each of the DACs. Note J6 is associated with DAC4, J7 with DAC3, etc.

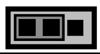
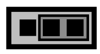
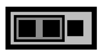
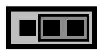
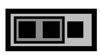
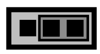
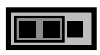
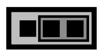
Jumper Number	DAC Number	Loading Sequence	
		LSB Last	MSB Last
J6	4		
J7	3		
J8	2		
J9	1	 LSB MSB	 LSB MSB

Figure 6 DAC LOADING MODES

The loading mode of each channel can be separately selected as indicated in the table shown in figure 6. Mixed loading modes can be supported on a single board. Factory default setting is all DACs loaded LSB first with the analog output updated on loading of the MSB.

2.5.5 Voltage Output Ranges (PC24E Only)

The voltage output range of the four DACs on the PC24E can be set by jumpers according to the table in figure 7. The four DAC channels can be independently selected for unipolar or bipolar operation, but the maximum output voltage set by jumper J3 applies to all four channels simultaneously.

The PC24E is supplied with all four channels set up and calibrated for +10V unipolar operation. If the range is changed, the output voltages should be checked and recalibrated if necessary using the procedure described in paragraph 2.5.8.

Jumper J3 is available on the PC25E, but would normally remain set at the default position of 10V. However, if special scaling of the PC25E for low current outputs is required, then jumper J3 may be positioned at 2.5V.

J3 Range Jumper	DAC Channel	Polarity Jumper	UniPolar Output Voltage Range	BiPolar Output Voltage Range
J3 10V 2.5V	1	J1	UP BP 0 to +10V	UP BP +10 to - 10V
	2	J2	0 to +10V	+10 to - 10V
	3	J4	0 to +10V	+10 to - 10V
	4	J5	0 to +10V	+10 to - 10V
J3 10V 2.5V	1	J1	UP BP 0 to +2.5V	UP BP +2.5 to -2.5V
	2	J2	0 to +2.5V	+2.5 to -2.5V
	3	J4	0 to +2.5V	+2.5 to -2.5V
	4	J5	0 to +2.5V	+2.5 to -2.5V

Figure 7 PC24E OUTPUT VOLTAGE RANGES

2.5.6 Installing the PC24E or PC25E in the Computer

When the board has been correctly set up for the application as described above, it may be installed in the host PC.

If this is the first time you have installed a peripheral card in your computer, you should refer to the hardware manual supplied with your machine for instructions on how to remove the cover and install devices into the input/output slot. The PC24E or PC25E may be installed in any available slot in the machine provided that there is no restriction specified for the slot by the manufacturer of the machine.

⚠ CAUTION ENSURE THAT THE POWER TO THE COMPUTER IS SWITCHED OFF BEFORE INSTALLING OR REMOVING ANY EXPANSION BOARD. ALWAYS WEAR AN EARTHED WRIST STRAP AND OBSERVE PROPER PRECAUTIONS IN HANDLING THE PC24E/25E AND ANY OTHER BOARDS BEING INSTALLED OR REMOVED. REPAIR OF DAMAGE CAUSED BY MIS-HANDLING IS NOT COVERED UNDER THE AMPLICON WARRANTY.

2.5.7 Testing the PC24E/25E

When installation is complete, the PC24E/25E can be tested by loading and running the programs on the supplied demonstration disk and measuring the fixed outputs using a digital multimeter or viewing the sine wave outputs on an oscilloscope. See section 4.

2.5.8 Calibrating the PC24E

When the output voltage range of any channel is changed by jumper selection, the calibration should be checked using the following procedure.

1. UniPolar Calibration

1.1 Ensure that the settings of jumpers J1, J2, J4 and J5 are correct for unipolar (UP) operation on the required channels and the desired voltage range, 2.5 or 10V, is set on J3. This voltage range applies to all four channels whether unipolar or bipolar.

1.2 Connect an accurate digital voltmeter to measure the voltage at the output of the first channel being calibrated.

1.3 Load and run the demonstration program PC24E/25E as described in section 4.

1.4 Select item 3 from the menu. ' Write a value to all four DACs'.

1.5 Enter the data value 4095 which gives a positive full scale output voltage of +2.500 or +10.000 as selected by J3. Press any key twice to load the DACs.

1.6 Adjust the appropriate trimmer potentiometer to give exactly +2.500V or +10.000V according to the setting of J3. The potentiometers located at the top of the board are adjusted according to the following table.

Channel (DAC) Nº	Output Pin Nº	Trimmer Pot.
1	11	RV1
2	9	RV2
3	7	RV7
4	5	RV8

1.7 If any channel will not adjust to the required value over the full span of the potentiometer, then raise or lower the reference voltage by adjusting RV13 until all channels can be correctly set up. Repeat the calibration procedure.

1.8 Enter 0 and confirm to exit the program

2. BiPolar Calibration

2.1 Ensure that the settings of jumpers J1, J2, J4 and J5 are correct for bipolar (BP) operation on the required channels and the desired voltage range, 2.5 or 10V, is set on J3. This voltage range applies to all four channels whether unipolar or bipolar.

2.2 Connect an accurate digital voltmeter to measure the voltage at the output of the first channel being calibrated.

2.3 Load and run the demonstration program PC24E/25E as described in section 4.

2.4 Select item 3 from the menu. ' Write a value to all four DACs'.

2.5 Enter the data value 4095 which gives a negative full scale output voltage of –2.500 or –10.000 as selected by J3. Press any key twice to load the DACs.

2.6 Adjust the appropriate trimmer potentiometer to give exactly –2.500V or –10.000V according to the setting of J3. The potentiometers located at the top of the board are adjusted according to the table below.

2.7 Select item 3 from the menu. ' Write a value to all four DACs'.

2.8 Enter the data value 0 which gives a positive full scale output voltage of +2.500 or +10.000 as selected by J3. Press any key twice to load the DACs.

2.9 Adjust the appropriate trimmer potentiometer to give exactly +2.500V or +10.000V according to the setting of J3. The potentiometers located at the top of the board are adjusted according to the following table.

Channel (DAC) Nº	**Output Pin Nº**	**Trimmer Negative**	**Potentiometer Positive**
1	11	RV1	RV5
2	9	RV2	RV6
3	7	RV7	RV9
4	5	RV8	RV10

2.10 If any channel will not adjust to the required value over the full span of the potentiometer, then raise or lower the reference voltage by adjusting RV13 until all channels can be correctly set up. Repeat the calibration procedure.

2.11 Repeat 2.4 through 2.9 until both ends of the scale are accurately set.

2.12 Enter 0 and confirm to exit the program.

2.5.9 Calibration Check of the PC25E

The PC25E has a single range of 4 to 20mA which is properly calibrated at the factory. This calibration can be checked if necessary using similar techniques to the above and measuring the output current with a digital multimeter on a suitable d.c. current range.

Setting a value of 4095 should produce 20mA and setting a value of 0 should produce 4mA.

3. ELECTRICAL CONNECTIONS

3.1 User Connections

All user input/output connections are via a 25 way D type connector PL1. The pinouts for this connector are shown in figure 8.

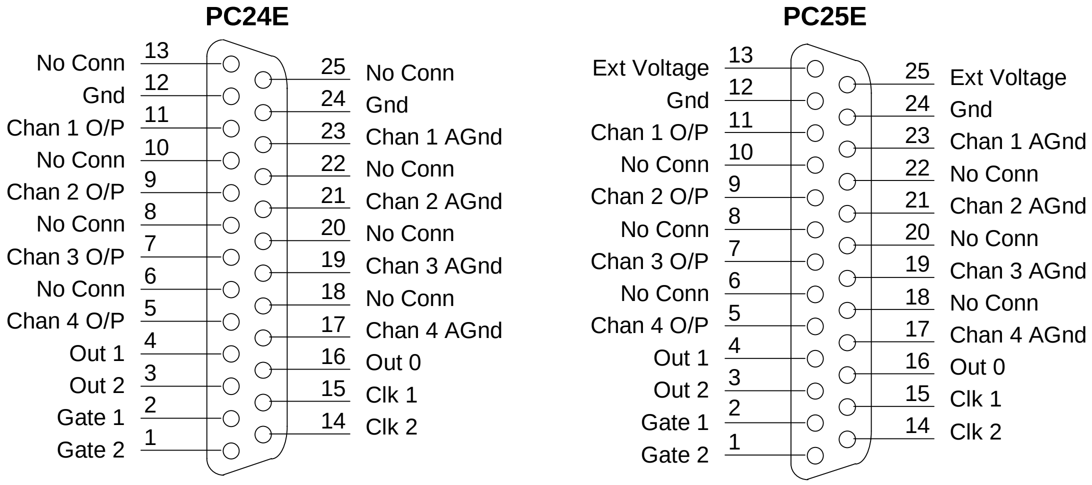


Figure 8 CONNECTOR PL1 PIN DESIGNATIONS

Notes to figure 8:

1. 'No Conn' means no connection to this pin
2. Chan 1 (channel 1) is the output of DAC 1, chan 2 the output of DAC 2 and so on.
3. Analog output channels should be referred to their own ground pins (AGnd)
4. Counter connections are available via jumpers J11, J12, and J16 to J20.
5. Ext (external) Voltage must be in the range +12 to +30 (max) volts DC.
6. Counter connections and external voltage inputs should be referred to Gnd (digital ground)

3.2 EMC Considerations

In order to maintain compliance with the EMC directive, 89/336/EEC, it is mandatory that the final system integrator uses good quality screened cables for external connections. It is up to the final system integrator to ensure that compliance with the Directive is maintained.

Amplicon Liveline offers a series of good quality screened cables for this purpose. Please contact our sales staff.

3.3 Main I/O Bus Backplane Connections

Connection to the computer is made through the 62 pin I/O bus connector (Pins B1 and A1 are at the bracket end of the board). Pin connections are shown in figure 9. For further information please consult the technical reference manual for the host computer.

	Ground	<	**B1**	**A1**	<	-I/OCHCK	
	+Reset	<	**B2**	**A2**	<>	SD7	
	+5Volts	<	**B3**	**A3**	<>	SD6	
	+IRQ2/9*	>	**B4**	**A4**	<	SD5	
	-5Volts	<	**B5**	**A5**	<>	SD4	
	+DRQ2	>	**B6**	**A6**	<>	SD3	
	-12Volts	<	**B7**	**A7**	<>	SD2	
	-0WS	<>	**B8**	**A8**	<>	SD1	C
	+12Volts	<	**B9**	**A9**	<>	SD0	O
	Ground	<	**B10**	**A10**	<	I/OCHRDY	M
S	-SMEMW	<	**B11**	**A11**	<>	AEN	P
O	-SMEMR	<	**B12**	**A12**	<>	SA19	O
L	-IOW	<>	**B13**	**A13**	<>	SA18	N
D	-IOR	<>	**B14**	**A14**	<>	SA17	E
E	-DACK3	<>	**B15**	**A15**	<>	SA16	N
R	+DRQ3	<>	**B16**	**A16**	<>	SA15	T
	-DACK1	<>	**B17**	**A17**	<>	SA14	
S	+DRQ1	<>	**B18**	**A18**	<>	SA13	S
I	-DACK0	<>	**B19**	**A19**	<>	SA12	I
D	CLK	<>	**B20**	**A20**	<>	SA11	D
E	+IRQ7	<>	**B21**	**A21**	<>	SA10	E
	+IRQ6	<>	**B22**	**A22**	<>	SA9	
	+IRQ5	<>	**B23**	**A23**	<>	SA8	
	+IRQ4	<>	**B24**	**A24**	<>	SA7	
	+IRQ3	<>	**B25**	**A25**	<>	SA6	
	-DACK2	<>	**B26**	**A26**	<>	SA5	
	+T/C	<	**B27**	**A27**	<>	SA4	
	+BALE	<	**B28**	**A28**	<>	SA3	
	+5Volts	<	**B29**	**A29**	<>	SA2	
	OSC	<	**B30**	**A30**	<>	SA1	
	Ground	<	**B31**	**A31**	<>	SA0	

* Note: Pin B4 is IRQ2 for an XT. Pin B4 is IRQ9 for an AT which is re-directed as IRQ2

Figure 9 MAIN PC BUS BACKPLANE CONNECTOR PIN ASSIGNMENTS

4. PROGRAMMING THE PC24E/25E

The PC24E/PC25E is supplied with a $3^1/_2$ inch diskette containing Windows DLLs with Microsoft Visual Basic example programs, and a Borland Turbo Pascal DOS demonstration program. See Section 2.4 to find out how to install the software onto your hard disk.

4.1 Windows DLLs and Visual Basic Example Programs

Having installed the software, you will find a number of Windows Dynamic Link Libraries (DLLs) each of which supports one basic Input/Output function available with the Amplicon low-cost Data Acquisition boards. Each DLL comes with a Visual Basic example program (source code is also provided), and any number of these programs can be run concurrently to build up the system represented by one or more of the boards being used.

The default installation for the PC24E/25E creates four new icons in the 'Amplicon Introductory DLLs' folder/Program Manager group:

DA24DEMO	- Visual Basic analog output demo program
TC53DEMO	- Visual Basic timer/counter demo program
README	- User Guide for the Amplicon Introductory DLLs
AMPLICON LIVELINE LTD	- What Amplicon offers you

To open any of these objects, simply double-click the mouse on the relevant icon.

For more information on the functions provided by the DLLs, and how to use them in your own Visual Basic Windows programs, please read the User Guide by double-clicking on the README icon.

4.2 Turbo Pascal Demonstration DOS Program

Two Turbo Pascal files are also installed into the Introductory DLL directory:

PC2425.PAS
PC2425.EXE

4.2.1 Loading the Program

Both source (PC2425.PAS) and executable (PC2425.EXE) versions of the demonstration programs are provided.

To run the Executable version of the demonstration program:

1. Boot up.
2. Log on to the disk drive or directory containing the demonstration software and type:

PC2425 <RETURN>.

4.2.2 Running the Demonstrations

After booting up and selecting PC2425.EXE, the first menu screen is displayed. The choices are:

1. Change PC24E/PC25E card base address.
2. Write a value to one DAC only.

3. Write a value to all DACs.

4. Output a Sine wave to one DAC.

5. Output a Sine wave to all DACs.

6. Exit.

Option 1 need only be chosen if a base address other than the factory set 300 hex has been set up on the board.

Enter a number 2 to 4 to choose the required output(s) and follow the on-screen instructions.

Note: All values are input as decimal numbers, which can take any value from 0 to 4095.

4.3 Input/Output Address Space used by the PC24E/PC25E

When writing application software for the PC24E/25E, the programmer will need to know the location of all DAC and Timer registers in the I/O space. These locations are given in figure 10 below, showing each register as an offset from the base address set up on the board. For example, if the base address is set at 300 hex, then the 82C53 control register is at 30B hex.

NOTE Selection of the order in which the MSB and LSB are loaded into the DACs (jumpers J6 - 9) has no effect on the register addresses.

Address	**Function**
BA + 00	DAC1 (lo byte)
BA + 01	DAC1 (hi byte)
BA + 02	DAC2 (lo byte)
BA + 03	DAC2 (hi byte)
BA + 04	DAC3 (lo byte)
BA + 05	DAC3 (hi byte)
BA + 06	DAC4 (lo byte)
BA + 07	DAC4 (hi byte)
BA + 08	82C53 Counter/Timer 0
BA + 09	82C53 Counter/Timer 1
BA + 0A	82C53 Counter/Timer 2
BA + 0B	82C53 Control Register

Figure 10 INPUT/OUTPUT ADDRESS SPACE

Notes to figure 10:

1. BA = Base Address as set on SW1.
2. Register address is Base Address plus offset.
3. Offset to be added to the BA is stated as a Hex value.

4.4 Programming the AD7548 Digital to Analog Converter

The PC24E/25E has been designed for straightforward user programming of the four DAC chips. Being 12 bit DACs they have to be loaded by sending the output data as two bytes to the appropriate DAC register addresses as shown in figure 10 above. Note that the data must be right justified and the order of sending the two bytes must be as selected by jumpers J6 to J9. The source code supplied with the demonstration software may be taken as examples of programming the DACs.

When the PC24E is operated in the Bipolar mode, writing 0 to the DACs will give a full POSITIVE output, writing 2047 (7FF hex) will give 0 volts and writing 4095 (FFF hex) will give full NEGATIVE output. The bipolar transfer function is shown in figure 11 below.

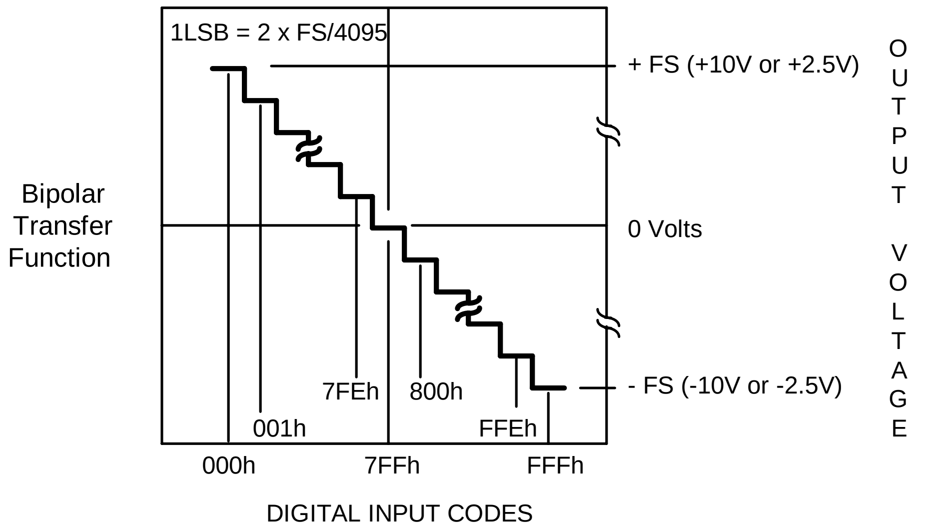


Figure 11 BIPOLAR TRANSFER FUNCTION

When operating the PC24E in the unipolar mode, writing 0 to the DACs will give 0V out and writing 4095 (FFF hex) will give full scale +2.5 or +10 V.

The PC25E is always unipolar and writing 0 to the DACs will give 4mA out and writing 4095 (FFF hex) will produce 20mA.

The unipolar transfer function is shown in figure 12 below.

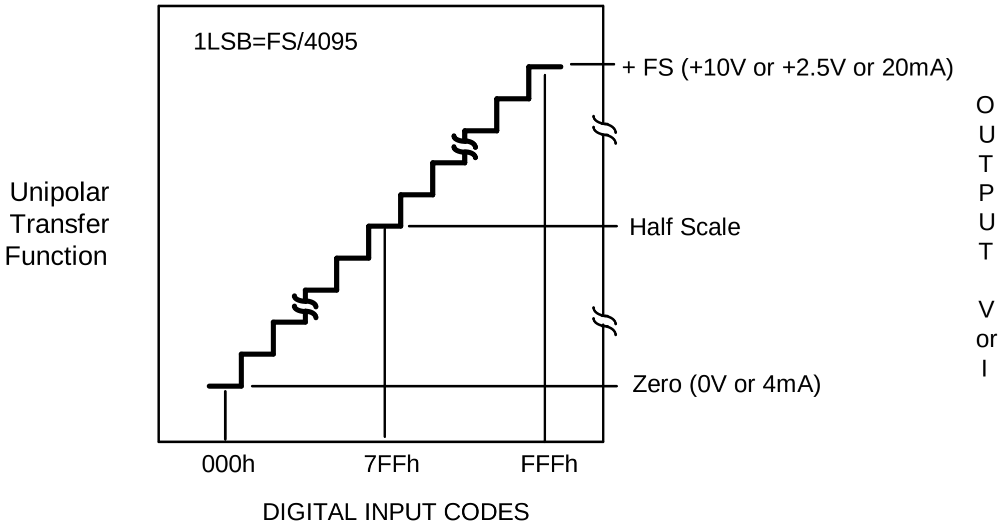


Figure 12 UNIPOLAR TRANSFER FUNCTION

4.4 Programming the 82C53 Counter/Timer

Full details of the 82C53 Counter/Timer and its various programming modes are given in the appendix. The three counter/timers of the 82C53 can be independently programmed to operate in any one of six modes, but circuit considerations mean that only mode 2, Rate Generator or mode 3, Square Wave Generator are useful for generating timed IRQ pulses.

The function of a particular timer/counter is established by writing a control word to the control register which is located at BA + 0Bhex. This 8 bit word consists of four fields as follows:

D7 D6	D5 D4	D3 D2 D1	D0
Select Counter	Read/Load	Select Mode	BCD or Binary

D0	= 0:	Binary counter selected.
	= 1:	BCD counter selected.
D3,D2,D1	= x 10:	Mode 2 Rate Generator selected.
	= x 11:	Mode 3 Square Wave Generator selected.
D5,D4	= 00:	Latch Counter.
	= 01:	Read/Load LSB
	= 10:	Read/Load MSB
	= 11:	Read/Load LSB followed by MSB
D7,D6	= 00:	Counter 0 selected.
	= 01:	Counter 1 selected.
	= 10:	Counter 2 selected.
	= 11:	Prohibited combination.

<u>Example 1</u> To select Counter 1 to Mode 3, loading/reading low order byte followed by high order byte binary, the controls word is:

0 1 1 1 0 1 1 0 = 76 hex.

This value has to be loaded to the control register whose address is Base Address + 0B. Assuming that the board address is 0300, the BASIC statement

OUT &H030B, &H76

will load the control register with 76 hex.

The value of the count has now to be loaded to the counter. The address of Counter 1 is base address + 09 which, in our example would be 0309. To load the value 50 decimal to this counter the following BASIC statement is used

OUT &H0309, &H32 : OUT &H0309, &H00

It should be noted that both the low order and high order bytes have to be loaded even though the high order byte, as in the above example, is zero.

Example 2 To read the current count on Counter 1 without affecting the counting operation the counter has to be latched. To do this the control word 0 1 0 0 0 1 1 0 (46 hex) is loaded to the control register by OUT &H030B, &H46.

The two bytes then have to be read from the latch using the command IN &H0309 to read the low order byte followed by IN &H0309 to read the high order byte.

The two bytes MUST be read before attempting to execute another write instruction on the same counter.

5. TECHNICAL SPECIFICATIONS

5.1 Electrical Specification

All Analog Outputs	Number of Channels	4
	Resolution	12 bits
	Relative Accuracy	±1 LSBit
	Differential Nonlinearity	±1 LSBit
	Settling time to 0.05% FSR	5µSec (Typ)
	Reference Stability	15 ppm/°C (Typ)
Voltage Outputs (PC24E)	Voltage Ranges	Unipolar 2.5 or 10V Bipolar ±2.5 or 10V
	Max. O/P Current (Source/Sink)	±10mA
Current Outputs (PC25E)	Range	4 to 20 mA
	Load Resistance (Internal Supply)	0 to 400Ω
	External Voltage (Ref Dig Gnd)	+12 to +24V (30 Max)
	Current Required from Ext Supply	80 mA
	Load Resistance (External 24V)	0 to 1000Ω
Clock Outputs	'Low' output voltage	+0.4v max at 2mA
	'High' output voltage	+3.7v min at -1mA.
Clock Source (Can be disabled)	Crystal Oscillator Frequency	1MHz
	Frequency Tolerance	±50 ppm
	Frequency Stability over temp range	±50 ppm
User I/O Connector	25 way male D type.	
Address Range	The board is addressable within the range 000-FF0 (Hex) at 16 bit boundaries. Twelve registers in I/O space.	
IRQ Range	Interrupt Request levels IRQ2 to IRQ7.	
Power	Powered from the host PC bus.	+5V at 200mA +12V at 50 mA * –12V at 50mA * *these may vary dependant on loads applied
Operating Conditions	Temperature Range	+5 to +50°C

5.2 Physical Specification

Fits 3/4 size IBM XT or AT compatible I/O expansion bus slot.

	Card Only	Packed
Height	107mm (+22mm locator tongue)	180mm
Width	20mm	90mm
Depth	215mm	420mm
Weight	0.2kg	0.4kg

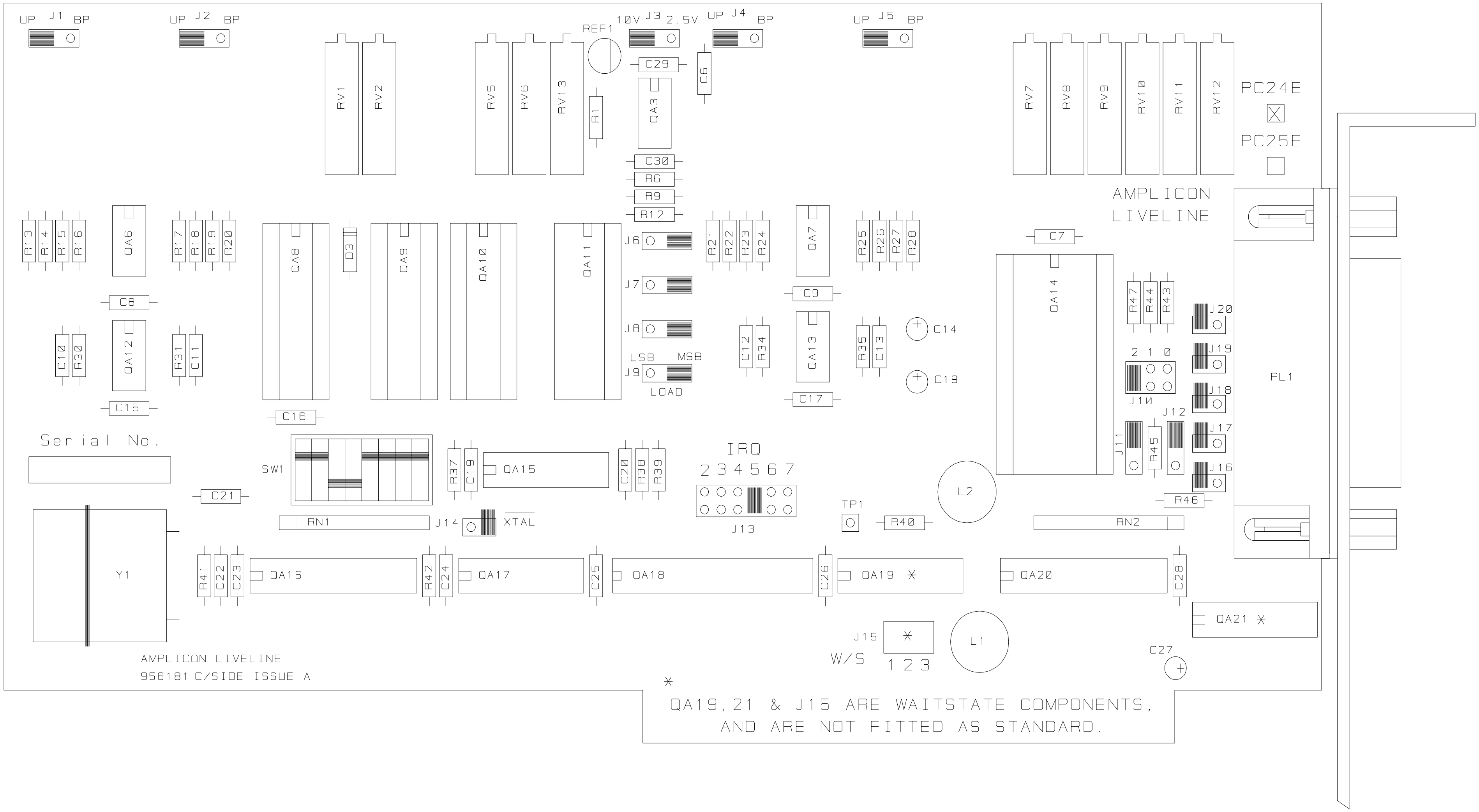


Figure 13 PC24E PRINTED CIRCUIT BOARD LAYOUT

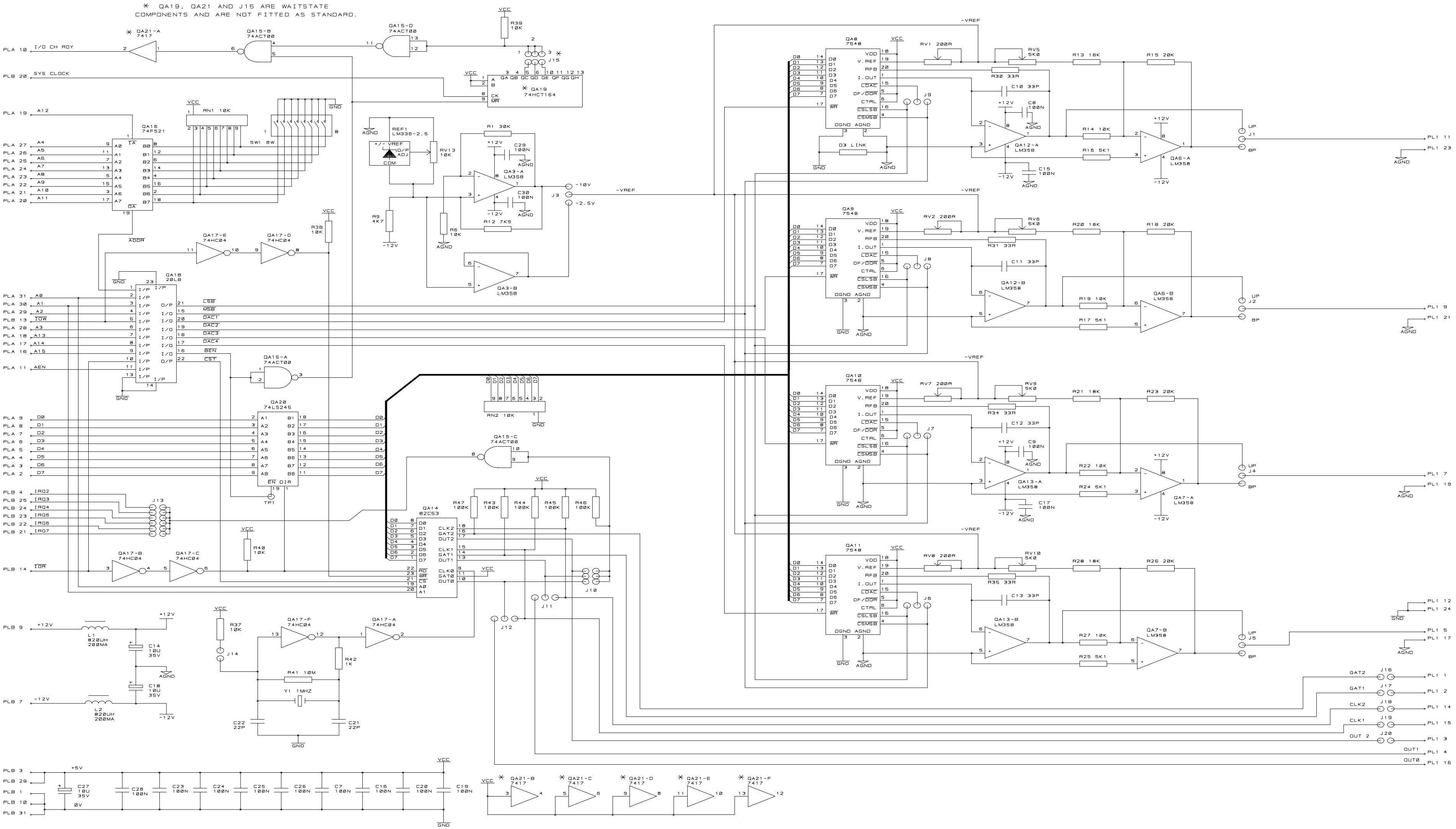


Figure 14 PC24E CIRCUIT DIAGRAM

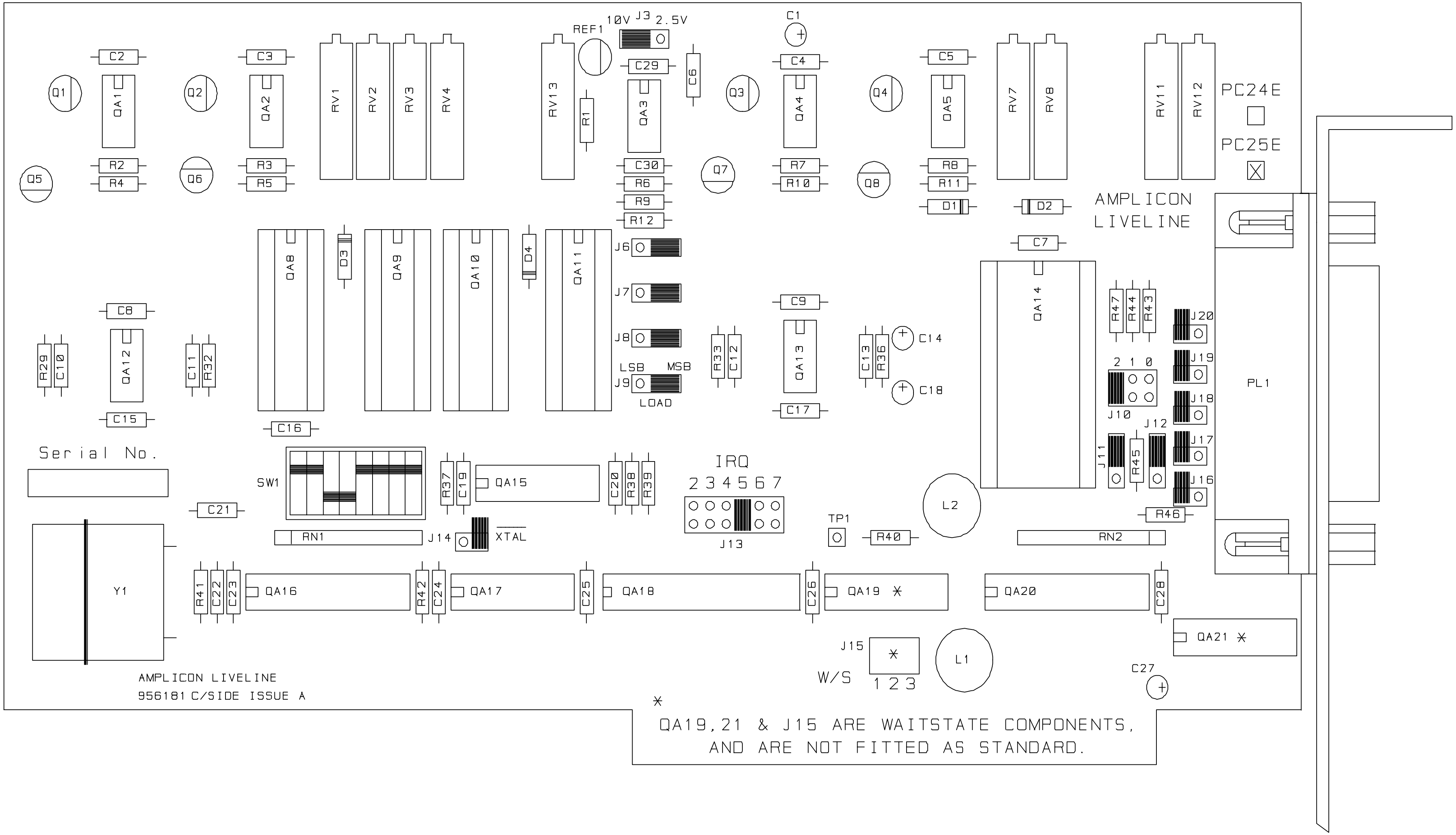


Figure 15 PC25E PRINTED CIRCUIT BOARD LAYOUT

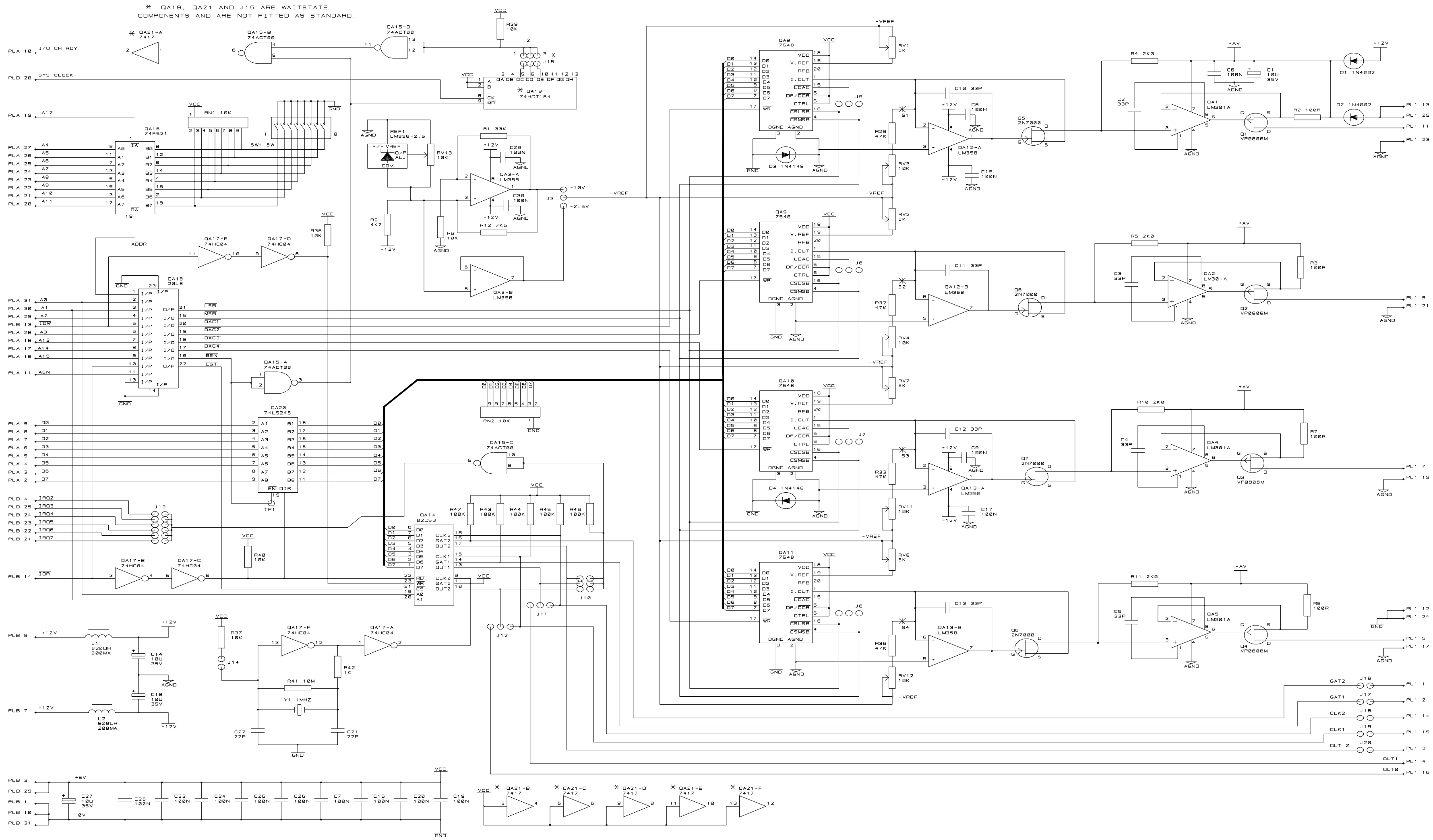


Figure 16 PC25E CIRCUIT DIAGRAM

6. NOTES